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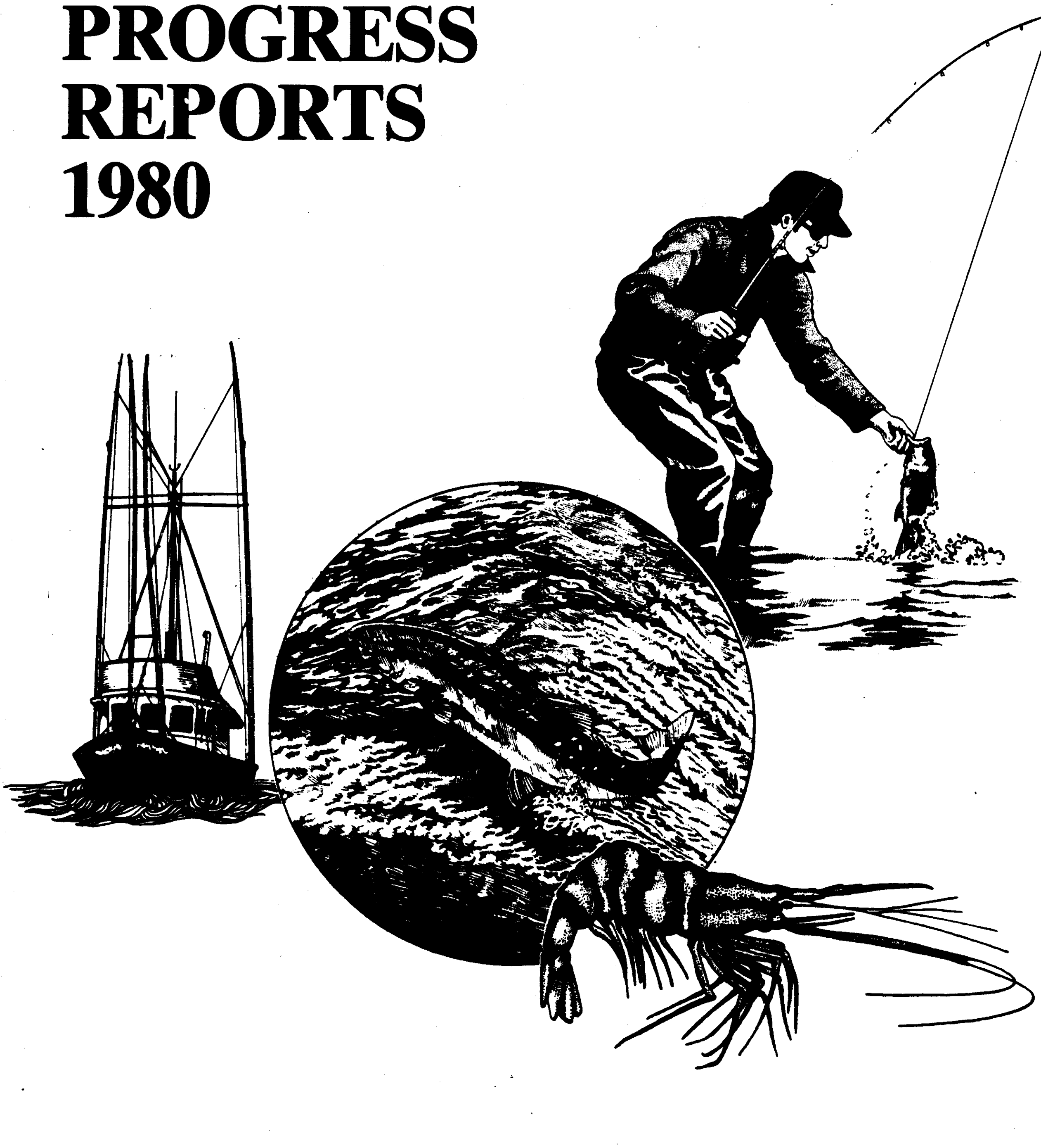
PROGRESS REPORTS 1980



FISH DIVISION

Oregon Department of Fish and Wildlife

Development of The Dalles Dam Trash Sluiceway
as a Downstream Migrant Bypass System, 1980

ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: Development of The Dalles Dam Trash Sluiceway as a Downstream Migrant Bypass System, 1980.

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INTRODUCTION

Background

Juvenile anadromous salmonids produced in the Columbia River and its tributaries above Bonneville Dam must pass from one to nine dams on their migration to the ocean (Fig. 1). Where there is no downstream migrant protection, fish pass these dams either through the turbines or over the spillway. The proportion of fish using either route varies from year to year with the proportion of water spilled. Studies at main-stem Columbia dams have shown that downstream migrants passing through turbines suffer a much higher mortality than those using spillways (Schoeneman et al. 1961). As more Columbia River hydroelectric and storage projects have been completed in recent years, spilling of excess water has decreased, forcing higher percentages of the juvenile salmonids to pass through the turbines. Consequently, there is an increased need to develop techniques to safely pass juvenile salmonids around dams, thus avoiding mortality to juveniles caused by turbines.

State and federal fisheries agencies have been investigating the following techniques to pass juvenile fish around main-stem dams: (1) Collecting fish at upstream projects and transporting them by truck or barge to the estuary below Bonneville Dam, (2) installing various deflection devices in turbine intakes to guide fish to bypass systems around dams, (3) manipulating flows to spill fish over dams or to pass them quickly through slack water reservoirs before their natural urge to migrate is lost, and (4) operating ice-trash sluiceways as surface skimming bypass systems.

The Oregon Department of Fish and Wildlife (ODFW), with funding from the U.S. Army Corps of Engineers, has extensively researched the use of The Dalles Dam sluiceway as a juvenile bypass system. The initial study by ODFW in 1977 (Nichols et al. 1978) determined the number and percentage of downstream migrants using the sluiceway under the operating criteria established by Michimoto (1971). Significant numbers of migrants (over 60,000 on peak days) used the sluiceway during the spring emigration period. However, only 40% of the juveniles passing the dam entered the sluiceway when the gate openings suggested by Michimoto (1971) were used. Large hourly and daily fluctuations in passage of salmonids through the sluiceway were observed.

During 1978 Nichols (1979) studied the effects of various sluice-gate openings on the attraction of juvenile salmonids into the sluiceway. Passage efficiency was greatly increased by opening the proper gates and by increasing flow through the sluiceway from 2,500 cfs (71 m^3/sec) to about 4,000 cfs (113 m^3/sec). The highest passage efficiency was achieved by using the largest surface flow possible through several adjacent skimmer gates on the southwest end of the powerhouse (above turbine unit 1). Fish collection efficiency was indirectly estimated at 80%. The sluiceway was operated 24 h/d between April 17 and August 4, and passed an estimated 3.7 million juveniles in 1978.

During 1979, Nichols (1981) determined that sluiceway operation could be reduced from 24 to 16 h/d with no significant reduction in fish passage. Significant numbers of migrants (1.3 million, primarily subyearling fall chinook) were bypassed through the sluiceway between July 1 and August 17, after the normal season of sluiceway operation. There was also an indication that fish passage through the sluiceway was best with gates open above turbine units 17

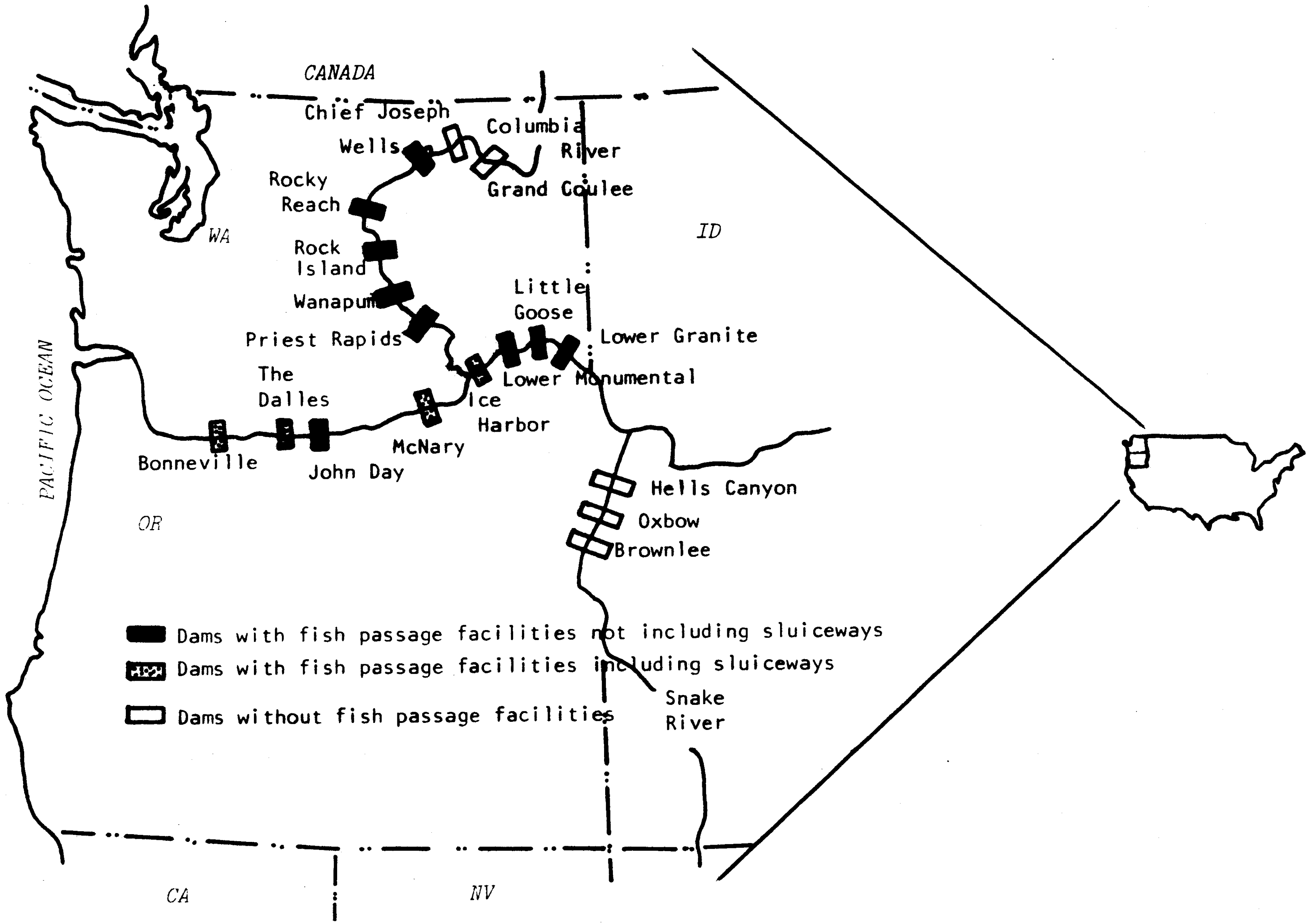

Fig. 1. Locations of dams affecting anadromous fish passage on the main-stem Columbia and Snake rivers.

and 18 rather than unit 1. It was recommended that the sluiceway be operated into August to protect these later migrating fall chinook. A prototype sampling device, using a stationary trap and fish pump capable of sampling fish without injury from the sluiceway was tested and found to warrant further development.

Study Objectives for 1980

During 1980 ODFW continued with studies funded by the Corps to develop The Dalles Dam sluiceway as a downstream migrant bypass system. The study objectives were:

1. Determine the relationship between flow and relative sluiceway passage of juvenile salmonids;
2. Estimate the bypass efficiency of yearling and subyearling salmonids at various flows into the sluiceway;
3. Determine which gates to open for maximum passage of subyearling chinook through the sluiceway;
4. Determine the abundance and diel distribution of late-migrating subyearling chinook;
5. Determine the efficiency of the fish sampler in the sluiceway and the condition of fish collected by it.

An additional objective to estimate mortality of juvenile salmonids using the sluiceway under full flow (4,000 cfs [112 m^3/s]) was eliminated because of failure by a contractor to the Corps to install equipment in adequate time.

METHODS

Sluiceway and Site Description

The Dalles Dam, located at river mile 192 (309 km), is unique among Columbia River dams in that its powerhouse is situated parallel to river flow (Fig. 2) instead of the typical perpendicular configuration. The sluiceway at The Dalles Dam is a large rectangular channel which extends along the forebay side of the powerhouse, immediately above the turbine intakes (penstocks) and adjacent to the gatewells (Fig. 3). It is 16.5 ft (5.0 m) wide, 49 ft (14.9 m) deep from the underside of the powerhouse deck to the bottom at elevation 134 ft msl (40.8 m), and 2,000 ft (690.6 m) long. The bottom of the sluiceway is level. The sluiceway wall closest to the forebay contains 70 adjustable skimmer gates (sluice-gates) which can be raised or lowered to let water and debris from the forebay enter (Fig. 4). There are three skimmer gates for each of the 22 main turbine units, which are numbered from southwest to northeast, and two each for the two fish turbines which provide auxillary water for the fishways. The three gates above each turbine are also numbered from southwest to northeast. For example, 16_3 denotes the northeastern gate over unit 16, and unit 16 is adjacent to the northeast of unit 15.

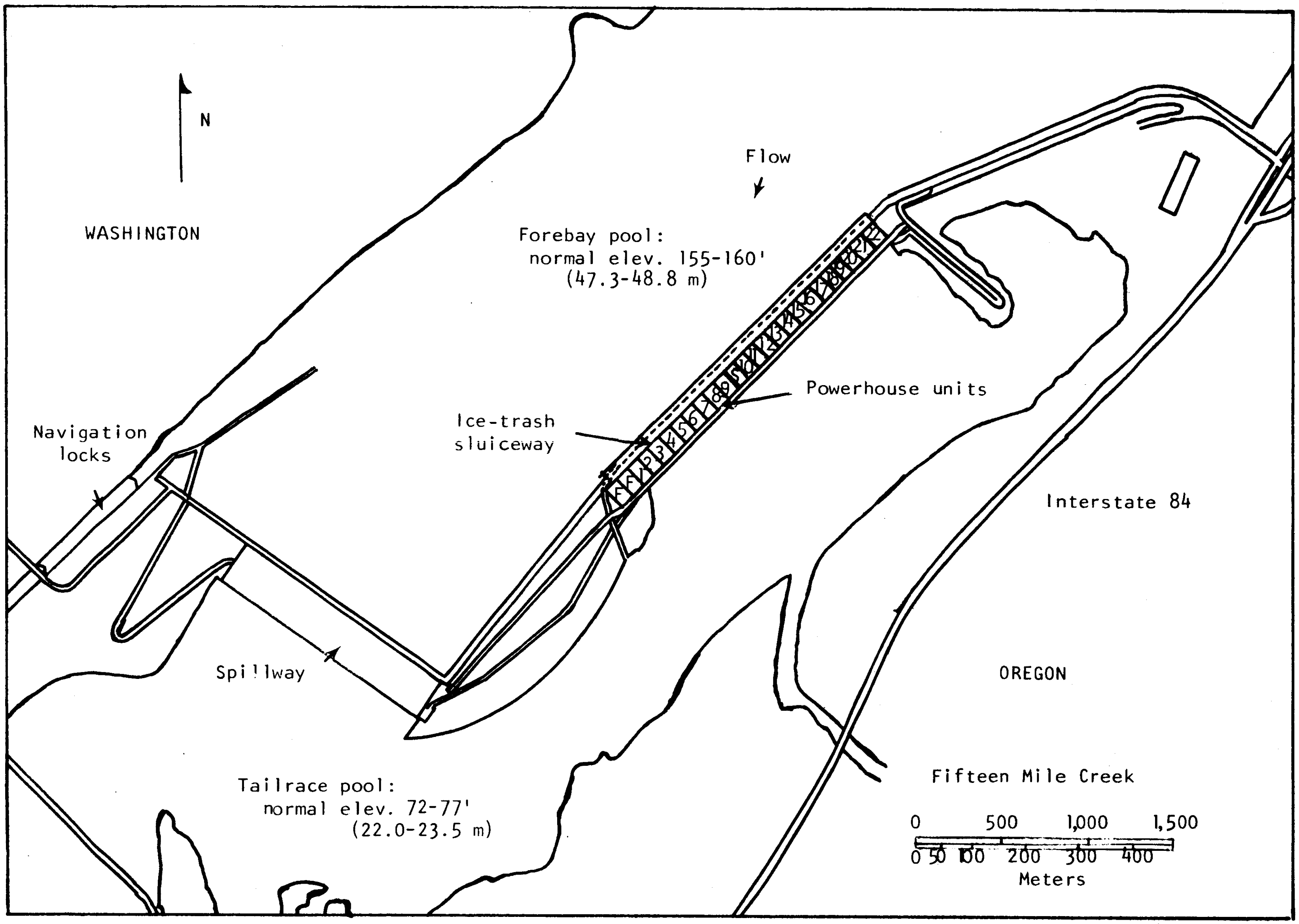

Fig. 2. Plan view of The Dalles Dam, Columbia River.

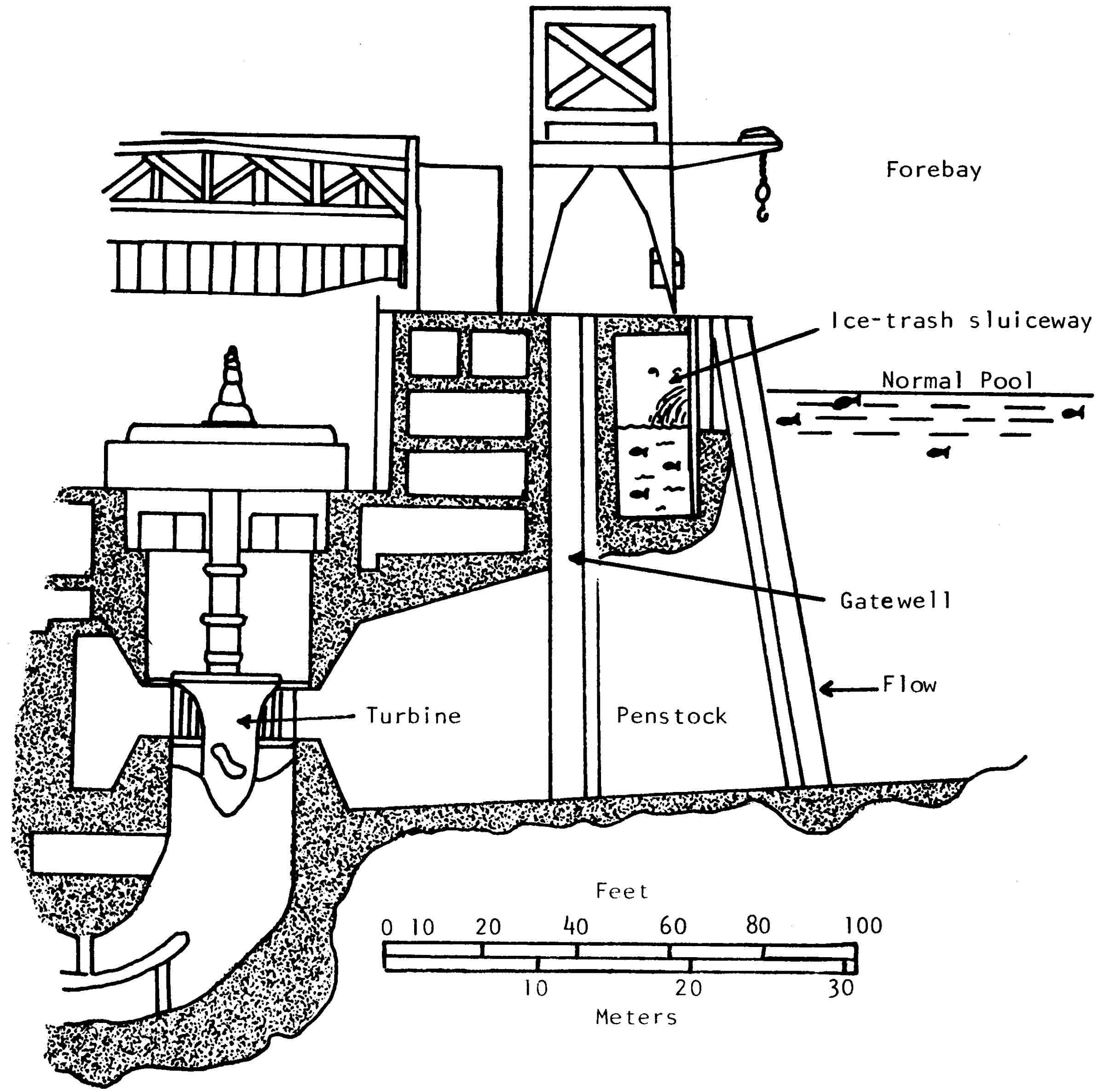

Fig. 3. Cross section of a Columbia River dam with a sluiceway.

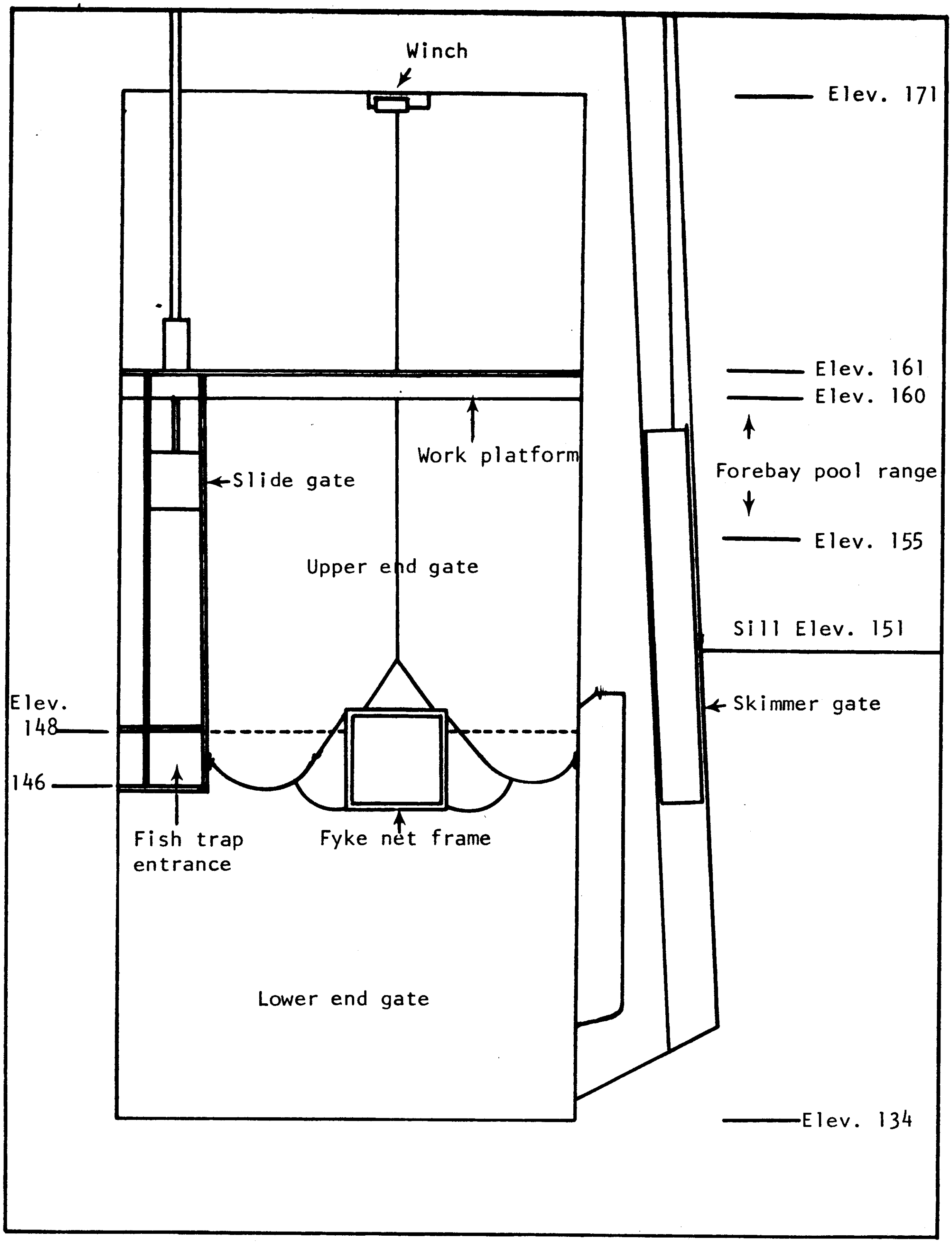

Fig. 4. Cross sectional view of The Dalles Dam sluiceway showing fyke net and fish trap locations.

Sluiceway Operation

Normally the forebay surface is held between elevation 155 and 160 ft (47.2 to 48.8 m). A sill in front of each skimmer gate at elevation 151 ft (46.0 m) limits the elevation to which the top of a gate can be effectively lowered. The option exists for creating submerged flow into the sluiceway by raising the bottom of the skimmer gate above this sill level; however, we used only surface overflow in 1980. For our study, only one gate within a group of three mechanized gates (for instance, 1_2 of the three gates over unit 1) was opened if flows less than 2,000 cfs (57 m^3/sec) were desired. If 2,000-3,000 cfs (57-85 m^3/sec) was to be used, two gates (i.e., 1_1 and 1_2) were opened, and for flows over 3,000 cfs (85 m^3/sec), three gates (i.e., $1_1 1_2 1_3$) were opened. When more than one gate was opened, care was taken to distribute the flow so that nearly equal amounts of water entered each gate. Since the hoists on these gates were automated, we were able to adjust the gates as the forebay level changed to ensure that inflow was constant. Typical water depth in the sluiceway was 9-14 ft (2.4-4.3 m) off the bottom.

We used a gate at the southwest end of the sluiceway to regulate water depth and velocity. This gate, termed the end gate, consists of two leaves which meet at elevation 148 ft (45.1 m) when sealing the sluiceway. Either lowering the bottom gate or raising the upper gate will permit water to flow through the sluiceway. Water enters the sluiceway from the forebay over or under the skimmer gates, flows southwest through the sluiceway channel, plunges over the end gate and onto a sloping concrete apron, and discharges into the tailrace pool through a raceway at nearly a right angle to the powerhouse.

During the peak of fish passage in the spring, the sluiceway was operated with flows of up to 5,000 cfs (142 m^3/sec) through three of the 70 adjustable skimmer gates. Fish that collected in the bulkhead slots (gatewells) emptied into the sluiceway through seventy 6-in (15.2 cm) orifices which pass a total of 280 cfs (7.9 m^3/sec). During off-peak passage of fish, the sluiceway operated under orifice flow only, or was closed off completely.

Fish Sampling Procedure

A fyke net was used to sample fish using the sluiceway. The net was attached to a metal frame, which was in turn attached to cables anchored on the sluiceway walls. Another cable was attached to the top of the net frame, and to an electric winch (see Fig. 4) which was used to raise and lower the net. The net itself (Fig. 5) was 20 ft (6.1 m) long and was equally divided lengthwise into two sections, the upstream section composed of 1 in (2.5 cm) square nylon mesh and the rear section of 1/4 in (0.6 cm) mesh. The fyke itself was eliminated since velocities fished (10-20 fps [3.0-6.1 m/s]) prevented escapement of fish. The net entrance was 3.5 ft (1.1 m) square, tapering to an 8 in (20.3 cm) cod end.

The numbers of downstream migrants passing through the sluiceway were estimated from net catches, as previously described by Nichols (1979). We generally fished the net for a portion of each hour, and then expanded the catch according to the net sampling efficiency to estimate the numbers of fish passing in 1 h. Actual fishing time was adjusted, based on our expectation of the catch rate, to sample approximately 100 fish per set. Fishing time was allotted to the middle of the hour for which passage was to be estimated.

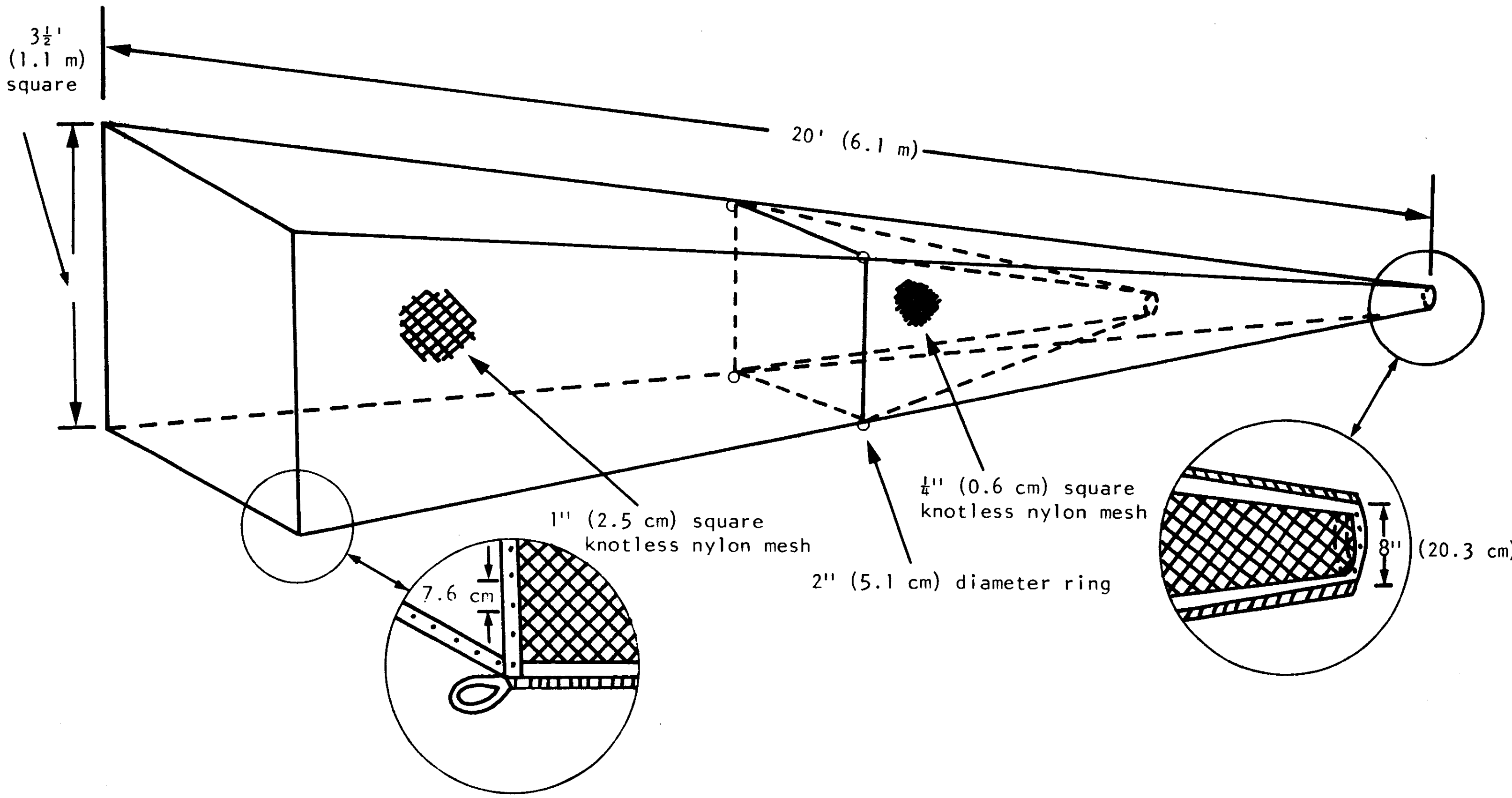

Fig. 5. Schematic diagram of fyke net used to sample juvenile salmonids in The Dalles Dam trash sluiceway.

During periods of high fish passage, or for special test purposes, samples were taken and passage estimates made for 30-min or 15-min periods.

Estimates of fish passage during hours or days that were not sampled were interpolated from adjacent estimates. Weekly estimates were made by adding daily totals.

We determined the sampling efficiency of the fyke net at various flows and gate settings by releasing known numbers of marked fish into the sluiceway and recapturing them with the net. We released 19 groups of 6,491-10,013 yearling coho or subyearling fall chinook at various flows through skimmer gates open on the southwest or northeast end of the powerhouse. Fish were released from a hatchery liberation truck through a 6 in (15.2 cm) flexible hose, into a 6 in (15.2 cm) vertical PVC pipe attached to the piernoses at skimmer gates 1_2 and 18_1 (southwest and northeast end, respectively). Each pipe had a 45^o elbow attached at the bottom and was adjusted so the released fish entered the water near the middle of the gate, just before it entered the sluiceway.

Determination of Operating Criteria and Efficiency

During 1980 the sluiceway was operated daily from April 12 to August 29 to pass juvenile salmonids, and periodically from October 1 through December 18 to estimate abundance and the diel passage distribution of late migrating fall chinook.

To compare passage of juvenile salmonids through the sluiceway under different gate openings (Objectives 1 and 3), we estimated fish passage through the sluiceway under one operating condition during the first half day and compared it with fish passage during the second half under an alternative condition. The parameter tested was alternated daily between the morning and afternoon periods. We selected the dividing time between these periods based on the most recent pattern of diel fish passage, such that fish passage should have been approximately equal between morning and afternoon periods. Diel patterns of fish passage were determined by making hourly passage estimates with the fyke net for at least two consecutive 24 or 16 h periods with a constant flow through the same gates.

To estimate the proportion of downstream migrants bypassed through the sluiceway (bypass efficiency) at various flows (Objective 2), groups of marked fish were released into the forebay at two sites upstream from the dam. As these fish moved through the sluiceway, passage estimates were made from net catches taken every 30 min. The primary release site for the groups of marked fish was the boat ramp at Horsethief Lake State Park on the Washington shore, 1.9 mi (3.1 km) upstream from the powerhouse. One group each of yearling coho and subyearling chinook were also released on the Oregon shore, off of Interstate 84 at a point 2.1 mi (3.4 km) upstream from the powerhouse.

To estimate bypass efficiency for yearling salmonids, we released two groups of yearling coho into the forebay when the sluiceway was operating under each of the following conditions: 1) Gates $1_1 1_2 1_3$ opened with 3,700 cfs (104 m^3/s), 2) gate 1_2 opened with 1,600 cfs (45 m^3/s) inflow, and 3) gates $1_2 18_3$ opened with 2,500 cfs (70 m^3/s) inflow. Release groups were comprised of 12,946- 16,431 fish (see Table 7). For each of the first two operating conditions of the sluiceway, one group of fish was released between 10 AM and noon and the second group was released between 3-4 PM. One group was cold branded while the other was unmarked. Fish from the unmarked group were distinguished from wild fish upon recapture in the sluiceway by their larger size and distinctive coloration. For the third sluiceway operating condition (gates $1_2 18_3$ opened with 2,500 cfs [70 m^3/s] inflow), the two groups of fish were released simultaneously, one from the Oregon shore and the other from the Washington shore.

To estimate bypass efficiency of subyearling chinook, we simultaneously released groups of 19,760 and 20,100 branded fall chinook from the Oregon and Washington shores, respectively. We operated the sluiceway with 1,600 cfs (45 m^3/s) inflow through gate 18_1 for 3 d following the release, and fished the sluiceway net at 30 min intervals during this time.

Determination of Flow Through the Sluiceway

In order to fulfill several objectives of the study, it was essential to know and control exact flow through the sluiceway. A Price-type water velocity meter (Teledyne Gurley type AA) which was used to measured water velocity, was mounted to the side of the fyke net frame with a 24 in (61.0 cm) steel bracket. We attempted to measure all velocities at six-tenths of the water depth in the sluiceway by lowering the frame to this depth with the electric winch. Velocity measurements were multiplied by the cross sectional area of the water column to determine flow. Flow estimates were made at various combinations of forebay elevations, end gate settings, and skimmer gates open.

For sluiceway flow estimates, the top of the end gate was set in three different positions: 1) Elevation 134 ft (40.8 m) at the bottom of the sluiceway where there was no weir effect, 2) elevation 138 ft (42.1 m) which was 4 ft (1.2 m) above the sluiceway floor, and 3) at elevation 142 ft (43.3 m), 8 ft (2.4 m) above the sluiceway floor. Skimmer gates were either fully closed or fully opened, and from one to three gates in unit one were opened at a time. After adjustments were made to the end gate or the skimmer gates, time was allowed, typically 15-30 min, for the sluiceway water level to stabilize at the new flow before velocity was measured.

The effects of these adjustments and forebay changes on flow are shown in Fig. 6. The largest single factor affecting flow in the sluiceway was forebay elevation. For example, with the end gate at elevation 134 ft (40.8 m), a forebay level increase from 155 ft to 160 ft (47.2 to 48.8 m) quadrupled the flow from 1,250 cfs to 5,000 cfs (35 m^3/s to 142 m^3/s). Even by opening additional gates, it would be impossible to put as much water through the sluiceway at lower forebay elevations as at higher elevations. With each additional gate opened a portion of the water backed upstream, reducing the head differential between the forebay and sluiceway, thus reducing the flow. This situation was aggravated as the end gate was raised.

Fish Trap-pump Evaluation

In 1980, we tested the operation of a fish trap-pump sampling apparatus in the sluiceway, which was potentially to be used for permanent index sampling of migrating juvenile salmonids. The apparatus was designed to capture fish

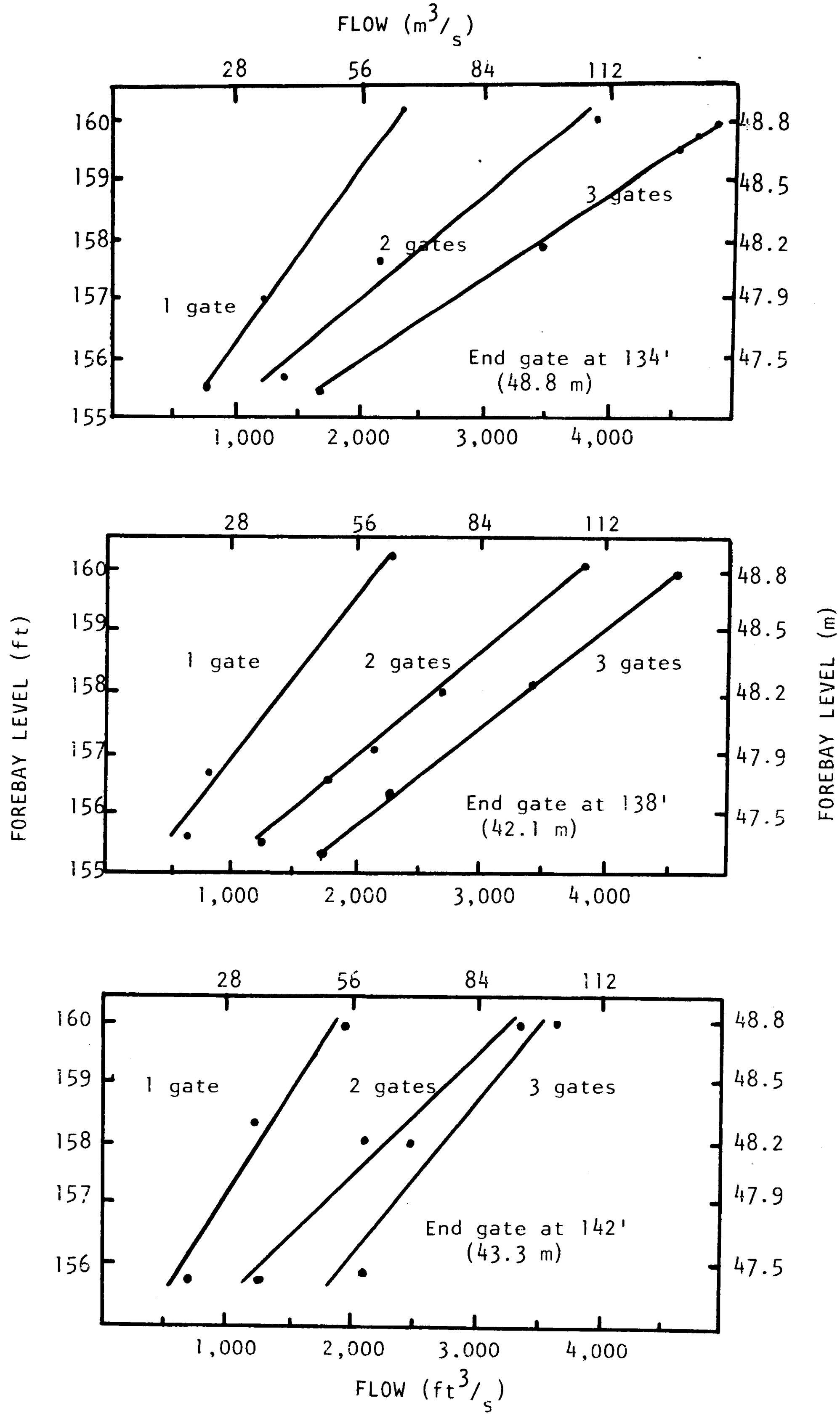

Fig. 6. Flows through sluiceway with various combinations of forebay elevations, end gate settings, and skimmer gates open above turbine unit 1.

without injuring them. The trap itself was made of smooth perforated steel plate and was 40 ft (12.2 m) long, tapering from a 2 ft x 2 ft (61 cm x 61 cm) opening down to a 6 in (15.2 cm) diameter fitting onto which a flexible reinforced hose was attached. The hose, in turn, was connected to a centrifugal pump of the type commonly used in salmon hatcheries to move fish. This fish pump sat above the trap on a work platform installed in the sluiceway at elevation 161 ft (49.1 m), or 1 ft (30.5 cm) above the normal high water line. The fish flowed into the trap, were pumped up the hose, flowed out onto a perforated plate where fish and water were separated, and dropped into a holding tank. A trash rack was situated in front of the trap mouth to screen out large debris. When the pump was not in operation a steel slidegate sealed off the trap entrance.

We evaluated the fish trap for three factors: (1) Sampling efficiency, (2) fish descaling, and (3) delayed mortality of captured fish. We estimated sampling efficiency at two flows by releasing hatchery fall chinook into the sluiceway and recapturing them with the trap. With 3,000 cfs (85 m^3/s) inflow through gates $1_2 18_1 18_2$ we released a group of 10,000 fish into the sluiceway. With 2,600 cfs (74 m^3/s) inflow through gates $18_1 18_2$ we released a group of 20,000 fish into the sluiceway. The release procedure was the same used to determine fyke net efficiency. In addition, simultaneous estimates of fish passage made with the trap and fyke net throughout the season were compared to indirectly estimate sampling efficiency.

To evaluate the extent of fish descaling caused by the trap, a group of 297 hatchery fall chinook were released directly into the trap entrance through a 4 in (10.2 cm) flexible hose while the pump was operating and flow in the sluiceway was approximately 3,000 cfs (85 m^3/s). The fish were examined for descaling before release and after being pumped into the holding tank. All naturally migrating salmonids caught with the trap were also examined for descaling.

To estimate mortality of fish collected with the trap, groups of marked fall chinook were released into the trap entrance, again through the 4 in (10.2 cm) hose while the sluiceway was operating at 3,000 cfs (85 m^3/s). These test fish were marked with an upper caudal fin clip. As the test fish entered the holding tank, a group of control fish marked with a lower caudal clip was poured into the holding tank. Both groups were then transferred to a 4 ft x 4 ft x 4 ft (1.2 m x 1.2 m x 1.2 m) net pen in the sluiceway, which by then had been closed off and filled to slack water. Two to three times a day for 2-4 days, dead fish were counted and removed from the holding pen. The test was conducted four times with different sources of fish. Other than the test fish being run through the trap, all test and control fish were handled identically (marking, hauling, holding).

RESULTS AND DISCUSSION

Estimated Fish Passage through the Sluiceway

Between April 12 and August 30, estimated passage of juvenile salmonids through The Dalles Dam sluiceway was 4.4 million fish (Table 1). There was extensive spilling of water over the spillway during June (24 d at an average 52,700 cfs [1,476 m^3/s]), which substantially descreased the number of juvenile salmonids passing through the powerhouse and sluiceway during that month. Passage of yearling salmonids peaked the first week in May while that of subyearlings peaked the second week in July (Fig. 7).

Table 1. Estimated weekly passage of juvenile salmonids through The Dalles Dam sluiceway during 1980.

Date	Yearling chinook	Subyearling chinook	Coho	Sockeye	Steelhead	Total
April 13-19[a]	71,800	--	--	700	2,000	74,500
20-26	104,700	--	--	200	46,500	151,400
27 May 3	187,600	3,800	--	500	61,300	253,200
4-10	492,400	3,400	--	19,900	169,200	684,900
11-17	317,700	113,700	--	25,900	131,400	588,700
18-24	277,800	36,400	1,900	28,500	122,600	467,200
25-31	171,700	4,900	13,800	24,800	40,100	255,300
June 1-7	162,700	14,500	16,500	17,700	24,800	236,200
8-14	23,700	103,600	3,200	5,700	7,500	143,700
15-21	27,600	136,500	1,400	3,500	5,400	174,400
22-28	27,600	225,600	800	2,100	1,500	257,600
29-July 5	--	340,700	--	--	--	340,900
6-12	--	378,900	--	--	--	378,900
13-19	--	121,200	--	100	--	121,300
20-26	--	64,800	--	--	--	64,800
27-August 2	--	91,700	--	--	--	91,700
3-9	--	96,400	--	--	--	96,400
10-16	--	30,600	--	--	--	30,600
17-23	--	3,800	--	--	--	3,800
24-30	--	2,800	--	--	--	2,800
Total	1,865,300	1,773,300	37,600	129,600	612,300	4,418,300

[a] *Includes 9,300 fish estimated to have passed April 12.*

The diel pattern of passage of yearling salmonids in 1980 was similar to 1978, with very little passage at night, and peak passage in the late morning (Fig. 8). Diel patterns of subyearling passage differed from that of yearlings, in that subyearling passage peaked at dusk (Fig. 9). Subyearling chinook passage peaked sharper when gates $17_3 18_1 18_2$ were used as opposed to gates $1_1 1_2 1_3$. The weekly passage of the most abundant miscellaneous species is presented in Table 2.

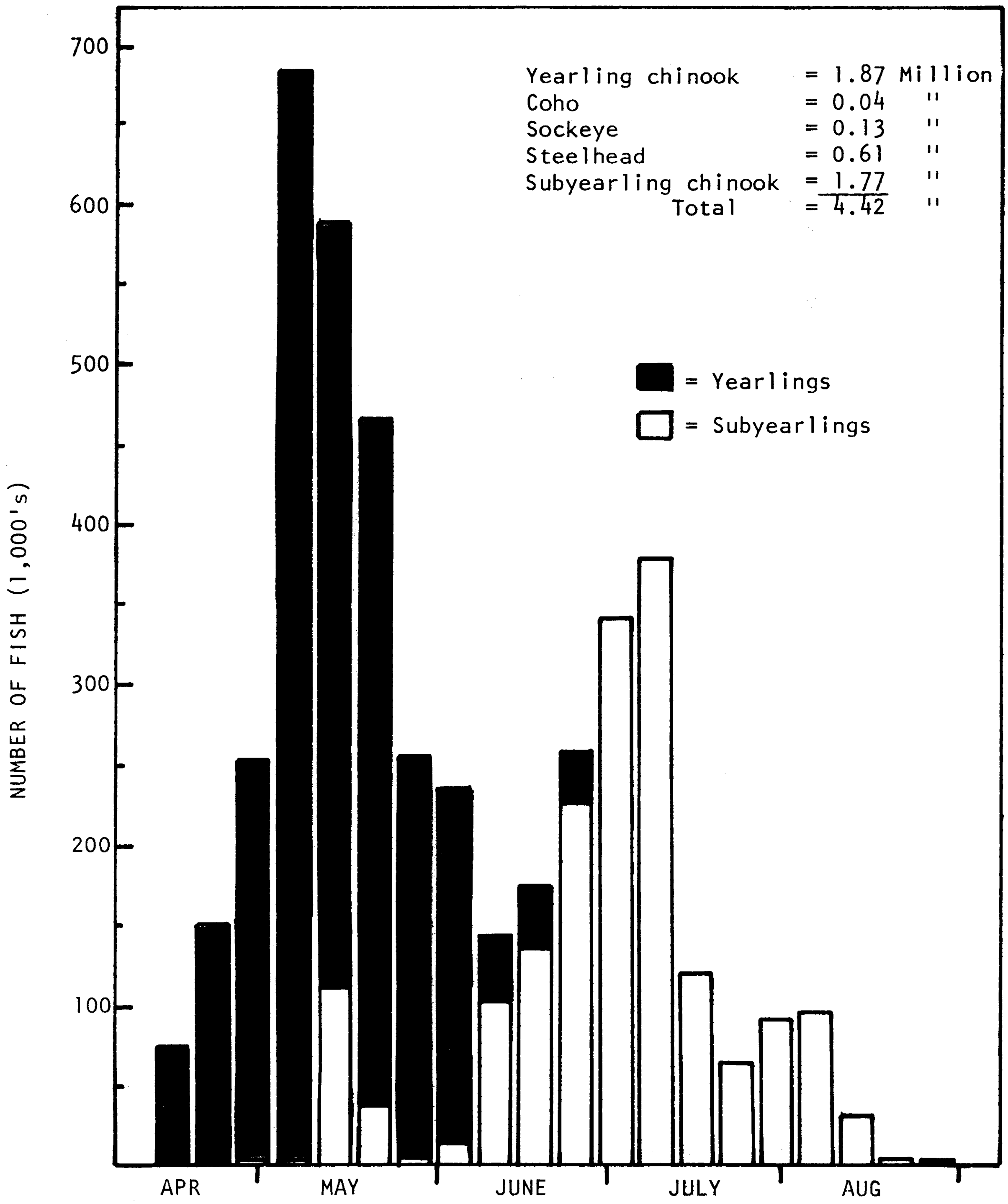

Fig. 7. Estimated weekly passage of juvenile salmonids through The Dalles Sluiceway during 1980.

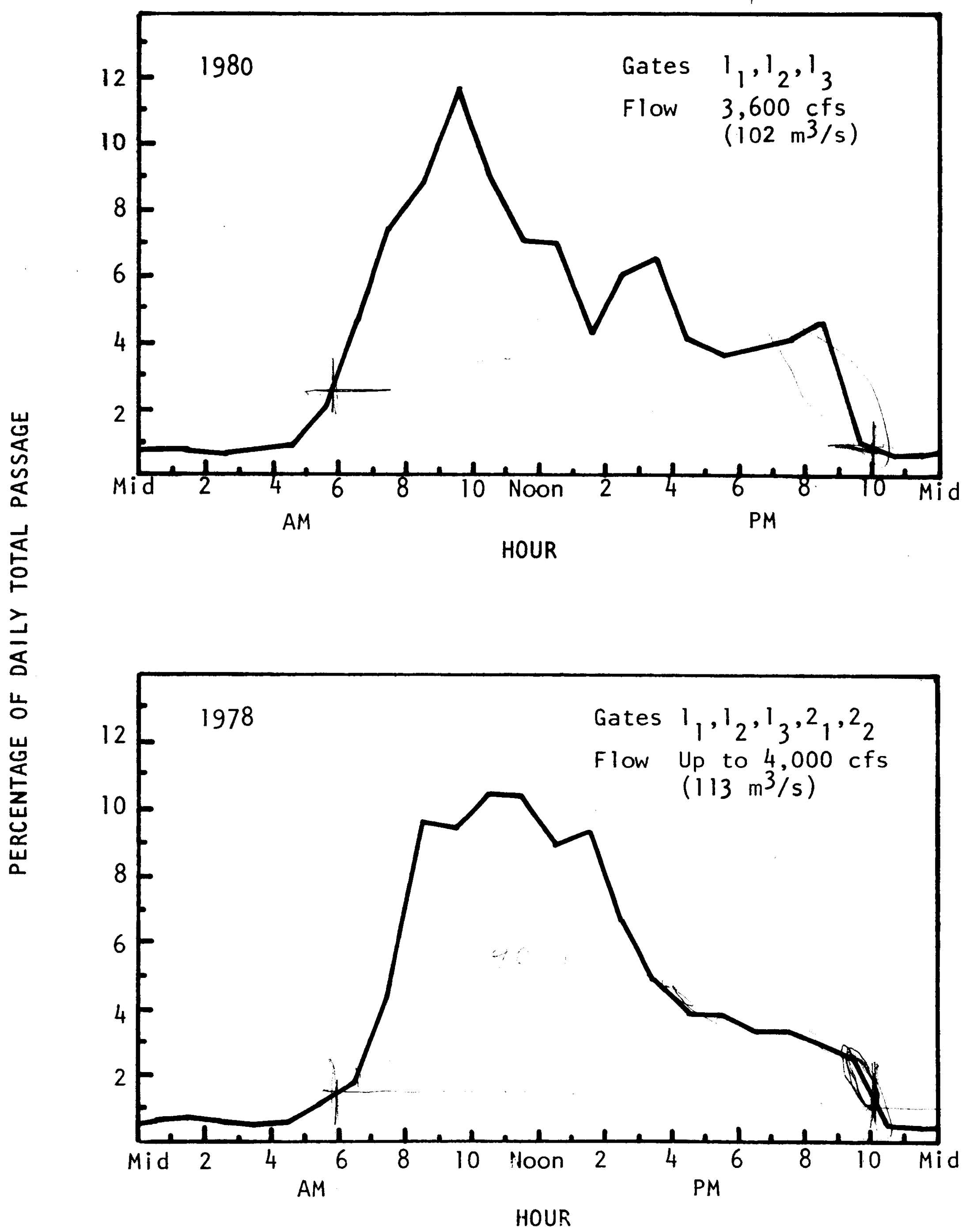

Fig. 8. Diel distribution of yearling salmonids passing through the sluiceway during 1978 and 1980.

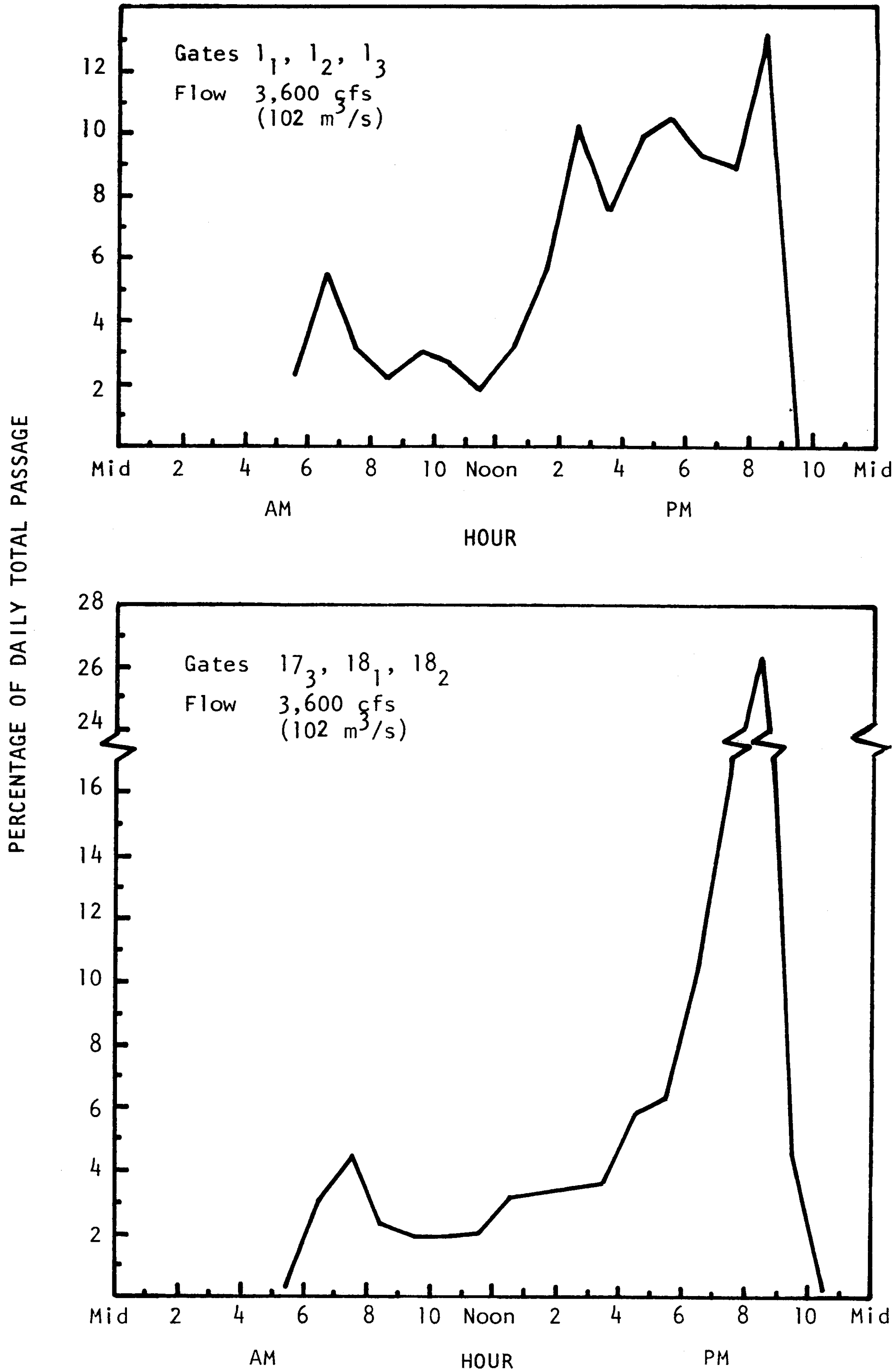

Fig. 9. Diel distribution of subyearling salmonids passing through the sluiceway during 1980.

Table 2. Estimated passage of common miscellaneous fishes through The Dalles Dam sluiceway during 1980.

Dates	Squawfish	Spring chinook Adult	Spring chinook Jack[a]	Adult steelhead Kelt[b]	Adult steelhead Unspawned	Adult shad	Walleye
April 13-19	0	0	0	0	0	0	0
20-26	0	0	0	70	0	0	0
27-May 3	0	0	0	0	131	0	0
4-10	274	988	0	988	55	0	0
11-17	157	0	105	315	0	0	52
18-24	1,635	1,412	0	1,189	74	0	0
25-31	624	134	0	178	0	0	0
June 1-7	137	46	0	274	0	0	0
8-14	139	0	0	46	0	0	46
15-21	240	90	0	60	0	0	30
22-28	1,491	178	0	71	0	426	0
29-July 5	0	0	0	0	0	0	0
6-12	6,828	414	310	0	0	8,586	0
13-19	1,840	378	0	48	0	2,420	0
20-26	529	125	0	31	31	3,767	0
27-August 2	6,391	144	0	0	36	17,911	0
3-9	2,429	0	0	0	0	8,108	0
10-16	188	0	0	0	0	1,196	0
17-23	549	0	0	0	0	4,890	0
Total	23,451	3,909	415	3,270	327	47,304	128

[a] *Chinook <24 in (61 cm).*
[b] *Spawned out.*

Objective 1. Determine the relationship between flow and sluiceway passage of juvenile salmonids.

We made three successive tests to compare passage of juvenile salmonids through the sluiceway at approximate flows of 1,700, 2,500, 3,700, and 4,500 cfs (48, 71, 105, and 127 m^3/s) through open gates over turbine unit 1. In the first test flows were alternated between 1,700 and 3,800 cfs, and passage was significantly greater ($p<0.0005$) at 3,800 cfs (108 m^3/s) than at 1,700 cfs (48 m^3/s) (Table 3). In the second test, flows were alternated between 2,500 and 3,700 cfs and passage at 3,700 cfs (105 m^3/s) was significantly greater ($p<0.025$) than at 2,500 cfs (71 m^3/s) (Table 4). In the third test, flows were alternated between 3,600 cfs (102 m^3/s) and 4,500 cfs (127 m^3/s), but fish passage was not significantly different between flows ($p>0.25$) (Table 5). Fish passing through the sluiceway during the first test (May 27-June 6) were yearling chinook and steelhead (68% and 13%, respectively), but by the third test (June 17-27) they were mostly yearling and subyearling chinook (54% and 42%, respectively) (see Table 1).

Table 3. Passage of juvenile salmonids through the sluiceway with 1,700 and 3,800 cfs (48 and 108 m^3/s) inflow through gates over turbine unit 1.

			Estimated fish passage				
			Low flow[a]		High flow[b]		
	Average flow (cfs)						
Date	Low	High	Fish passed	% of daily total	Fish passed	% of daily total	Daily total
May 27	*1,552*[c]	3,656	*9,809*	*33.4*	19,535	66.6	29,344
28	1,774	*3,673*	9,739	22.8	*32,900*	*77.2*	42,639
29	*1,499*	3,681	*11,019*	*32.3*	23,144	67.7	34,163
30	1,780	*3,864*	6,766	27.7	*17,659*	*72.3*	24,425
June 2	*1,723*	3,792	*7,336*	*24.0*	23,235	76.0	30.571
3	*1,685*	3,825	*11,510*	*21.6*	41,693	78.4	53,203
4	1,604	*3,773*	9,570	23.6	*31,009*	*76.4*	40.579
5	*1,663*	3,855	*9,292*	*38.7*	14,730	61.3	24,022
6	1,729	*3,717*	7,855	24.5	*24,211*	*75.5*	32,066
Mean	1,668	3,760	27.6%		72.4%		
Total			82,896		228,116		311,012

Test for difference in % fish passed: t = 4.04, df = 16, one sided $p<0.005$.

[a] *Gate 1_2 open.*
[b] *Gate $1_1 1_2 1_3$ open.*
[c] *Data in italics were collected during afternoon from 11:30 AM-9 PM. Data in standard print were collected during morning from 5-11:30 AM.*

Table 4. Passage of juvenile salmonids through the sluiceway with 2,500 and 3,700 cfs (71 and 105 m^3/s) inflow through gates over turbine unit 1.

	Average flow (cfs)		Estimated fish passage: Low flow[a]		Estimated fish passage: High flow[b]		
Date	Low	High	Fish passed	% of daily total	Fish passed	% of daily total	Daily total
June 9	*2,492*[c]	3,673	*7,783*	*54.5*	6,534	45.6	14,317
10	2,474	*3,720*	5,293	22.4	*18,388*	*77.6*	23,681
11	*2,532*	3,656	*8,221*	*57.8*	5,992	42.2	14,213
12	2,527	*3,750*	7,427	25.9	*21,276*	*74.1*	28,703
13	*2,546*	3,792	*10,340*	*48.8*	10,857	51.2	21,197
16	2,585	*3,784*	5,980	27.8	*15,539*	*72.2*	21,519
Mean	2,526	3,729	39.5%		60.5%		
Total			45,044		78,586		123,630

Test for difference in % fish passed: $t = 2.30$, $df = 10$, one sided $p<0.025$.

[a] *Gates $l_1 l_3$ open.*
[b] *Gates $l_1 l_2 l_3$ open.*
[c] *Data in italics were collected during afternoon from 11:30 AM-9 PM. Data in standard print were collected during morning from 5-11:30 AM.*

Table 5. Passage of juvenile salmonids through the sluiceway with 3,600 and 4,500 cfs (102 and 127 m^3/s) inflow through gates over turbine unit 1.

Date	Average flow (cfs)		Estimated fish passage[a]				
			Low flow		High flow		
	Low	High	Fish passed	% of daily total	Fish passed	% of daily total	Daily total
June 17	3,836	*4,523*[b]	6,243	46.8	*7,099*	*53.2*	13,342
18	*3,880*	4,538	*13,376*	*34.4*	25,563	65.6	38,939
19	3,858	*4,541*	23,970	65.1	*12,859*	*34.9*	36,829
20	*3,761*	4,476	*7,398*	*40.6*	10,846	59.4	18,244
23	3,795	*4,366*	16,581	54.7	*13,736*	*45.3*	30,317
24	*3,792*	4,443	*15,843*	*34.2*	30,538	65.8	46,381
26	*3,759*	*4,318*	25,447	69.4	*11,204*	*30.6*	36,651
27	*3,372*	4,425	*11,578*	*36.7*	19,990	63.3	31,568
Mean	3,757	4,454	47.7%		52.3%		
Total			120,436		131,835		252,271

Test for difference in % of fish passed: t=0.65, df = 14, one sided p>0.25.

[a] *Gates $1_1 1_2 1_3$ open.*
[b] *Data in italics were collected during afternoon from 1-9 PM. Data in standard print were collected during morning from 5 AM-1 PM.*

The ratio of high to low flow in each test was significantly correlated (R^2=0.994, $p<0.05$) to the corresponding ratio of the percentages of fish passed at each flow implying there is a constant proportionality between increasing flow and increasing fish passage through the sluiceway. However, results of these tests may be invalid. After the tests were completed, we discovered that turbine unit 1 had been turned off while these three tests were conducted. Turbine unit 2 was operational and passing 15,000 cfs (420 m^3/s). Since there was no flow attracting fish to turbine unit 1, one might expect that increasing flow through skimmer gates above unit 1 would attract proportionately increasing numbers of fish. A reasonable doubt exists that these tests could be duplicated with unit 1 functioning. The possibility still exists that maximum attraction of fish into the sluiceway could be achieved at less than full flows into the sluiceway.

We also estimated passage of subyearling fish through the sluiceway at inflows of 1,600 cfs (45 m^3/s) through gate 18_1 and 3,500 cfs (99 m^3/s) through gates $17_3 18_1 18_2$. Fish passage with 3,500 cfs (99 m^3/s) inflow was over four times that with 1,600 cfs (45 m^3/s) inflow, with no day showing greater fish passage on the low flow ($p<0.005$, Table 6). With tests at only two inflows, it is impossible to determine the geometric form of the releationship between passage of subyearlings and flow through northeast gates. Obviously, fish attraction was poor when inflow was 1,600 cfs and attraction increased sharply when flow was 3,500 cfs. Since the number of fish available is finite, the relationship between fish attraction and inflow must become curvelinear at some point. Beyond some level of inflow, further increases in flow will have less of an effect on fish attraction; however, we cannot speculate what level this might be.

<u>Objective 2.</u> Estimate the bypass efficiency of yearling and subyearling salmonids at various flows into the sluiceway.

<u>Yearlings</u>

We estimated the bypass efficiency of the sluiceway at three different inflows: 1,600 cfs, 2,500 cfs and 3,700 cfs (45 m^3/s, 70.0 m^3/s, and 104 m^3/s, respectively). The proportion of fish recaptured in the sluiceway was consistent between replicate release groups (Table 7), with most fish passing through the sluiceway within 12-24 h following release. However, several factors lead us to believe that our results were biased by the unnatural behavior of our test fish. In our first test (May 7) with 3,700 cfs flowing into the sluiceway, an average of 41.6% of our test fish were bypassed through the sluiceway (Table 7). In our second test (May 9), we reduced flow into the sluiceway to 1,600 cfs, but estimated bypass efficiency was still 40.5%, nearly identical to our first test. Our results under Objective 1, based on passage of wild fish, indicated that bypass efficiency should have been considerably greater at the higher inflow. Also, these estimates of bypass efficiency are only about one-half of the values we expected based on indirect estimates of bypass efficiency made in 1978 (78%) (Nichols 1979) and 1979 (85%) (Nichols 1981).

Table 6. Passage of subyearling salmonids through the sluiceway with 1,600 and 3,500 (45 and 99 m^3/s) inflow through northeast skimmer gates.

Date	Average flow (cfs)		Estimated fish passage				
			Low flow[a]		High flow[b]		
	Low	High	Fish passed	% of daily total	Fish passed	% of daily total	Daily total
July 21	*1,697*[c]	3,511	*4,323*	*22.8*	14,657	77.2	18,980
24	*1,598*	3,341	*1,484*	*24.6*	4,555	75.4	6,039
25	1,548	*3,440*	1,307	24.1	*4,121*	*75.9*	5,428
26	*1,579*	3,538	*498*	*4.9*	9,566	95.1	10,064
27	1,649	*3,603*	297	17.8	*1,373*	*82.2*	1,670
Mean	1,614	3,487	18.8%		81.2%		
Total			7,909		34,272		42,181

Test for difference in % of fish passed: $t = 11.95$, $df = 8$, one sided $p<0.005$.

[a] *Gate 18_1 open.*

[b] *Gates $17_3 18_1 18_2$ open.*

[c] *Data in italics were collected during evening from 6:30-10 PM. Data in standard type were collected during morning and afternoon from 6 AM-6:30 PM.*

Table 7. Estimated percentages of coho released in the forebay which were bypassed through the sluiceway at three different inflows.

Release date	Flow cfs	Flow (m^3/s)	Gates open	Group 1 Fish released	Group 1 % bypassed	Group 2 Fish released	Group 2 % bypassed	Average % bypassed
May 7	3,700	(104)	$1_1 1_2 1_3$	13,005	42.9	12,946	40.5	41.7
May 9	1,600	(45)	1_2	12,976	37.7	12,946	41.6	39.6
May 14	2,500	(70.0)	$1_2 18_3$	16,431	58.0	15,900	52.9	55.5

Because of the similarity in results of our tests at the first two flows, we decided to open gates at the opposite ends of the powerhouse (1_2 and 18_3) for our last test with 2,500 cfs flowing into the sluiceway. Under this condition, our estimate of bypass efficiency jumped to 60.6% (Table 7). This again was a surprising result since our tests in 1978 (Nichols 1979) indicated the attraction of wild yearling salmonids was poor through northeast gates ($17_2 17_3$).

It appears from these discrepancies in our results that the groups of hatchery coho we released to meet Objective 2 were behaving differently than naturally migrating fish. The odd behavior of our test fish may have been due to several factors, including stress from their transport to the release site, lack of thorough mixing in the river before reaching the powerhouse, and/or lack of adjustment to the river environment.

Comparison of our estimates for bypass efficiency with the number of juvenile salmonids estimated passing John Day Dam further suggests that our estimated bypass efficiencies are substantially low. If only 40% efficiency were realized, expansion of 1980 estimates of fish passage through the sluiceway would indicate that over 11 million juveniles passed the dam (4.42 million ÷ 0.40). This number is much larger than the estimate by the National Marine Fisheries Service (Sims et al. 1981) of 8.51 million juveniles passing John Day Dam in 1980. If we assume a 13% mortality rate through the John Day Dam turbines (Raymond and Sims 1980), and 7% mortality between John Day and The Dalles dams (approximated from data presented by Raymond 1979), then 6.62 million fish should have reached The Dalles Dam. Our 1980 estimate of 4.42 million fish passing through The Dalles Dam sluiceway would then represent a bypass efficiency of 67%, more in line with our 1978 and 1979 estimates. This is especially true when one considers that large numbers of juvenile salmonids included in the estimate of fish passing John Day Dam must have passed over the spillway at The Dalles Dam during the 24 d of spill in June.

Subyearlings

Bypass efficiency of the sluiceway for subyearling fish was to be estimated through northeast gates at flows of 1,600 cfs (45 m^3/s) and 3,700 cfs (104 m^3/s). In the first test on July 22 with 1,600 cfs (45 m^3/s) inflow, we simultaneously released 19,760 subyearling fall chinook from the Oregon shore and 20,100 from the Washington shore. Each group had a unique brand. We estimated that only 4% of the fish from the Oregon shore release and 1% of those from the Washington shore release passed through the sluiceway. Apparently the hatchery fall chinook used for the test did not migrate. At the same time about 20,000 naturally migrating chinook were moving through the sluiceway each day.

If these test fish did indeed represent only 4% of the total fish passage, then 500,000 wild fish were passing the dam daily. This figure is unrealistic since roughly 50,000 subyearling chinook were estimated to be passing John Day Dam daily at this time of year (Sims et al. 1981). Since the hatchery fall chinook used did not migrate, further test releases were not made.

Objective 3. Determine the optimum gates open for maximum passage of subyearling chinook through the sluiceway.

We compared the number of subyearling chinook passing through the sluiceway when gates $1_1 1_2 1_3$ were open with that when gates 17_3 18_1 18_2 were open, while maintaining an inflow near 3,600 cfs (101 m^3/s). We found no significant difference ($p>0.20$) in passage between the two gate settings (Table 8).

In 1979, we concluded that 60% more subyearling chinook passed through the sluiceway when gates $17_2 17_3 18_1 18_2$ were opened than when gates $1_1 1_2 1_3 2_1$ were opened. During 1980, we released over 47,000 yearling coho in six groups and 118,000 subyearling chinook in 13 groups into the sluiceway to determine fyke net sampling efficiency (Tables 9 and 10). At inflows from 3,500-4,500 cfs (99-127 m^3/s) the sampling gear recaptured four times more fish released through gates $17_3 18_1 18_2$ (17.2%) than through gates $1_1 1_2 1_3$ (4.4%). In 1979, we had assumed our fyke net sampling efficiency was constant. Our tests in 1980, therefore, indicate that our conclusion in 1979 was incorrect and that more subyearlings actually passed through gates $1_1 1_2 1_3 2_1$ than through gates $17_2 17_3 18_1 18_2$.

Objective 4. Determine abundance and diel distribution of late migrating subyearling chinook.

Periodic sluiceway operation and sampling was initiated in early October and continued through mid-December to determine passage characteristics of late migrating subyearling chinook. When the sluiceway was operating, gates $1_1 1_2 1_3$ were fully opened and inflow averaged 3,600-4,000 cfs (102-113 m^3/s). Estimated daily passage during October was 1,400 fish, up from passage estimates in late August of about 1,000 fish. Passage in November averaged 2,100 subyearling chinook daily, and in December 1,200 fish daily (Table 11). These estimates should be interpreted with caution because they are based on only 2-3 d sampling each month. Also, 15.4% of these fish were adipose clipped hatchery fish.

The diel distribution of fish passage in October was similar to that in the spring and summer, with virtually all of the fish moving during daylight hours and very few passing at night (Fig. 10). Based on these findings, sampling in November and December was limited to daylight hours.

Table 8. Passage of subyearling salmonids through the sluiceway with 3,600 cfs (102 m^3/s) flow through northeast or southwest end skimmer gates.

	Average flow (cfs)		Estimated fish passage				
			Gates $17_3 18_1 18_2$		Gates $1_1 1_2 1_3$		
Date	Gates $17_3 18_1 18_2$	Gates $1_1 1_2 1_3$	Fish passed	% of daily total	Fish passed	% of daily total	Daily total
July 28	3,607	*3,751*[a]	5,049	80.6	*1,214*	*19.4*	6,263
29	*3,534*	3,774	*19,025*	*45.9*	22,404	54.1	41,429
30	3,618	*3,790*	8,860	77.8	*2,522*	*22.2*	11,382
31	*3,529*	3,802	*4,263*	*21.5*	15,533	78.5	19,796
August 1	3,582	*3,771*	4,043	69.6	*1,763*	*30.4*	5,806
4	*3,534*	3,738	*4,323*	*59.0*	2,998	41.0	7,321
5	3,538	*3,830*	12,505	54.7	*10,366*	*45.3*	22,871
6	*3,435*	3,331	*7,864*	*39.6*	11,985	60.4	19,849
7	3,774	*3,880*	7,931	38.6	*12,631*	*61.4*	20,562
8	*3,470*	3,567	*5,841*	*51.1*	5,594	48.9	11,435
11	3,535	*3,914*	678	25.2	*2,017*	*74.8*	2,695
12	*3,470*	3,697	*3,842*	*30.2*	8,864	69.8	12,706
13	3,553	*3,761*	953	37.2	*1,607*	*62.8*	2,560
14	*3,558*	3,317	*1,535*	*31.3*	3,377	68.8	4,912
Mean	3,553	3,703	47.3%		52.7%		
Total			86,712		102,875		189,587

Test for difference in % of fish passed: $t = 0.73$, $df = 26$, one sided $p \leq 0.2$.

[a] *Italics indicates data collected during afternoon sampling period. All other data were collected during morning.*

Table 9. Recapture rates with the sluiceway net of yearling coho released into the sluiceway at various flows and gate openings.

Date	Gates open[a]	Flow cfs	Flow (m^3/s)	Number of fish released	Percentage recovered
May 8	$1_1 1_2 1_3$	3,730	(104)	9,257	5.9
"	$1_1 1_2 1_3$	3,730	(104)	9,267	5.9
May 10	1_2	1,540	(43)	7,005	9.3
"	1_2	1,630	(46)	6,986	12.3
May 15	$1_2 18_3$	2,600	(73)	6,491	7.5
"	$1_2 18_3$	2,170	(61)	8,000	10.9

[a] *All releases were through gate* 1_2 *except second release on May 15 which was through gate* 18_3.

Table 10. Recapture rates with the sluiceway net of subyearling chinook released into the sluiceway at various flows and gate openings.

Date	Gates open[a]	Flow cfs	Flow (m^3/s)	Number of fish released	Percentage recovered
July 23	18_1	1,540	(43)	8,022	9.8
"	18_1	1,540	(43)	8,033	14.4
July 24	$17_3 18_1 18_2$	2,880	(81)	10,000	15.2
July 25	18_1	1,490	(42)	8,008	19.9
"	18_1	1,540	(43)	8,098	23.2
July 28	$17_3 18_1 18_2$	3,730	(104)	8,025	20.8
"	$17_3 18_1 18_2$	3,520	(99)	8,025	15.6
July 29	$1_1 1_2 1_3$	3,840	(108)	10,013	4.8
"	$1_1 1_2 1_3$	3,800	(106)	10,013	3.1
July 30	$17_3 18_1 18_2$	3,700	(104)	10,013	13.7
"	$17_3 18_1 18_2$	3,610	(101)	10,001	20.6
July 31	$1_1 1_2 1_3$	3,800	(106)	10,001	5.2
"	$1_1 1_2 1_3$	3,800	(106)	10,013	4.5

[a] *All releases were through gate* 18_1 *except July 29 and July 31 which were through gate* 1_2.

Table 11. Estimated hourly passage of subyearling chinook through the sluiceway, October to December 1980.

Hour	Date: 10/1	10/2	11/5	11/6	11/7	12/16	12/17	12/18
Mid-1	X[a]	41	X	--	--	X	--	--
1-2	X	0	X	--	--	X	--	--
2-3	X	0	X	--	--	X	--	--
3-4	X	36	X	--	--	X	--	--
4-5	X	36	X	--	--	X	--	--
5-6	X	74	X	--	--	X	--	--
6-7	X	0	X	0	--	0	0	--
7-8	X	0	X	424	--	0	0	0
8-9	X	0	0	0	0	0	0	393
9-10	X	640	445	0	456	495	104	296
10-11	X	293	0	578	0	303	44	115
11-Noon	X	120	0	661	0	0	49	27
Noon-1	X	0	0	0	180	0	109	62
1-2	X	0	0	0	0	0	29	88
2-3	X	263	763	0	922	217	181	85
3-4	213	98	1,350	0	209	53	81	X
4-5	186	0	--[b]	0	X	44	93	X
5-6	0	116	--	342	X	0	184	X
6-7	0	0	--	0	X	86	83	X
7-8	102	45	--	96	X	28	37	X
8-9	207	45	--	--	X	54	118	X
9-10	251	X	--	--	X	34	44	X
10-11	47	X	--	--	X	--	--	X
11-Mid	53	X	--	--	X	--	--	X
Total	1,059	1,803	2,513	2,101	1,767	1,314	1,157	1,067
Mean	Oct: 1,431			Nov: 2,127			Dec: 1,179	

[a] *Sluiceway closed.*
[b] *Sluiceway open, but no estimate made.*

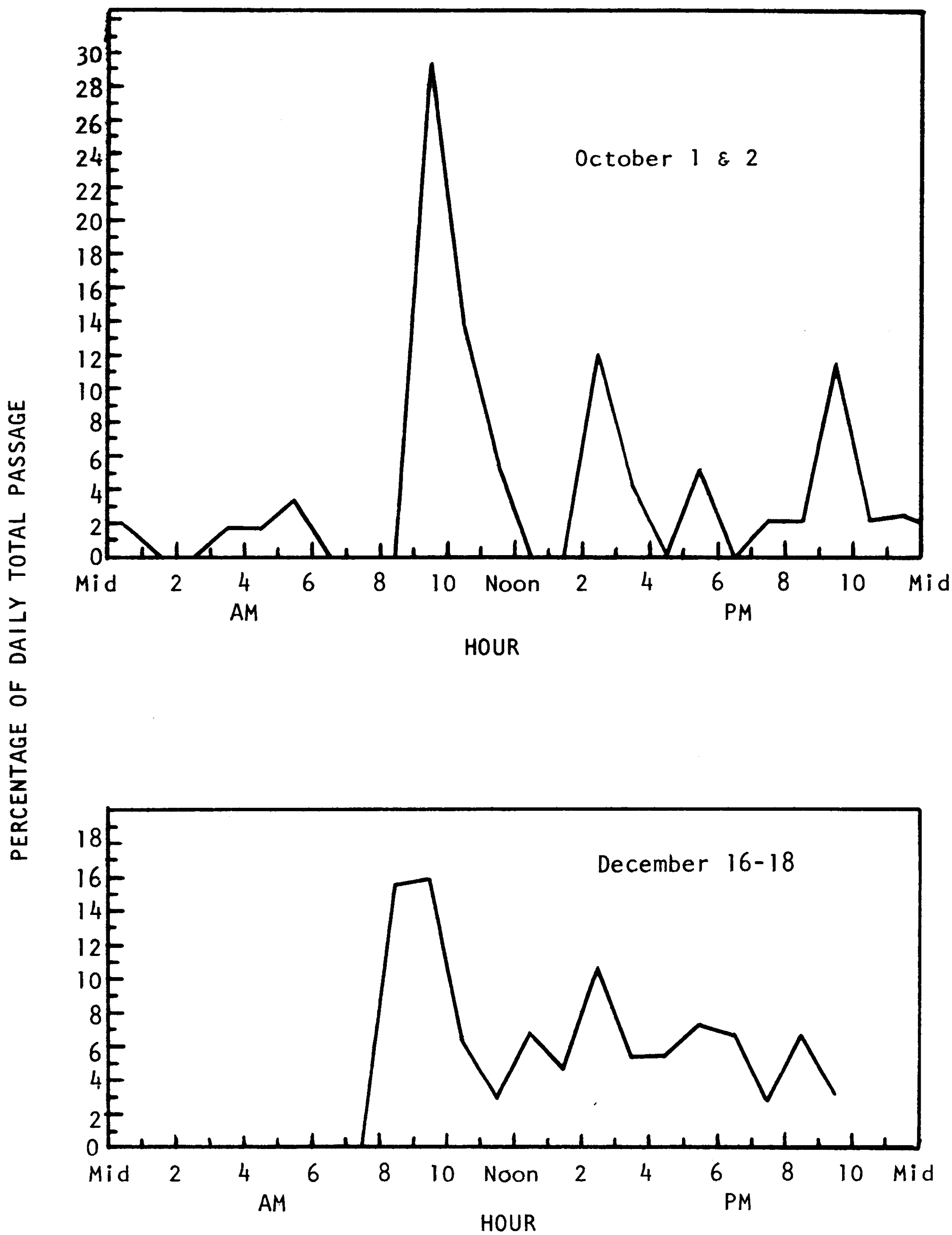

Fig. 10. Diel pattern of subyearling chinook passing through the sluiceway in October and December, 1980.

Extremely large numbers of juvenile shad passed through the sluiceway in the fall months. Passage of shad averaged 700,000 fish daily in October, 2.4 million fish daily (with a peak of 4.8 million) in November, and 400,000 fish daily in December (Table 12). The diel pattern of juvenile shad migration was similar to that of the subyearling chinook.

<u>Objective 5.</u> Determine the sampling efficiency of the fish trap-pump sampler in the sluiceway and the condition of fish collected by it.

<u>Sampling Efficiency</u>

Two groups of hatchery fall chinook were released into the sluiceway to estimate the fish trap sampling efficiency, one at gate 1_2 and one at gate 18_1. The proportion of fish recovered from those released at gate 1_2 (nearest the fish pump), approximated the proportion of the cross-sectional area fished, which indicates that the fish were being well mixed in the water column (Table 13). This result was similar to that with our fyke net. With the release at gate 18_1, virtually no fish were recovered (0.025%) (Table 13). This was probably due to fish orienting themselves in the center of the sluiceway away from the sluiceway wall where the trap was attached. As noted earlier, with about the same water levels and areas fished, fish were recaptured in the fyke net at a rate about four times greater (17.2% vs 4.4%) when released through northeast rater than southwest sluice-gates (Table 10). This indicates fish were orienting themselves in the center of the sluiceway when they traveled the 1,700 ft (518 m) distance from 18_1 to the net. The trap fishes at the same elevation as the net but near the wall rather than the center of the sluiceway (see Fig. 4).

We compared the sampling efficiency of the trap to that of the fyke net by simultaneously sampling with both gears. Estimates of fish passage derived from catches in the two gears (based on cross-sectional area sampled) were similar when only skimmer gates over turbine unit 1 were opened. When skimmer gates were opened over both units 1 and 18, catches in the trap-pump produced inflated estimates of fish passage. When only northeast skimmer gates ($17_3 18_1 18_2$) were opened, no fish were captured in the trap-pump sampler.

Table 12. Estimated hourly passage of juvenile shad, in thousands, through the sluiceway, October to December 1980.

Hour	Date 10/1	10/2	11/5	11/6	11/7	12/16	12/17	12/18
Mid-1	X[a]	1.0	X	--	--	X	--	--
1-2	X	1.2	X	--	--	X	--	--
2-3	X	1.8	X	--	--	X	--	--
3-4	X	1.4	X	--	--	X	--	--
4-5	X	1.2	X	--	--	X	--	--
5-6	X	0.7	X	--	--	X	--	--
6-7	X	24.5	X	27.2	--	14.6	7.6	--
7-8	X	254.3	X	128.6	--	869.4	160.1	41.7
8-9	X	239.5	0	38.4	160.8	49.5	9.9	0.6
9-10	X	191.6	1087.1	75.8	82.8	25.1	0	0.1
10-11	X	89.7	872.9	379.2	33.9	0.2	0	0.1
11-Noon	X	39.3	677.4	126.7	18.5	0	0	0.1
Noon-1	X	31.9	440.8	144.3	70.0	0.2	0	0.1
1-2	X	50.0	685.1	128.0	23.0	0.1	0.1	4.7
2-3	X	12.9	673.4	128.3	131.8	0.4	0.1	0.1
3-4	153.7	12.0	385.7	217.7	84.9	2.2	0	X
4-5	131.4	11.8	--[b]	114.9	X	2.2	4.1	X
5-6	59.4	11.7	--	50.5	X	3.1	4.3	X
6-7	61.5	13.6	--	1.0	X	2.1	3.5	X
7-8	10.0	1.8	--	2.7	X	8.7	2.9	X
8-9	8.4	4.2	--	0	X	1.2	2.0	X
9-10	7.4	X	--	0	X	2.7	1.2	X
10-11	8.3	X	--	0	X	--	--	X
11-Mid	7.0	X	--	0	X	--	--	X
Total	447.1	996.1	4822.4	1563.3	805.7	981.7	195.8	47.5
Mean	Oct: 721.6			Nov: 2397.1			Dec: 408.3	

[a] *Sluiceway closed.*
[b] *Sluiceway open, but no estimate made.*

Table 13. Recapture rates with the fish trap-pump of subyearling chinook released into the sluiceway.

Gates open	Number released	Gates where released	Flow (cfs)	Percentage recovered	% cross sectional area fished
$1_2 18_1 18_2$	10,000	1_2	3,000	1.50	1.43
$18_1 18_2$	20,000	18_1	2,600	0.025	1.73

Table 14. Simultaneous estimates of fish passage through the sluiceway with the fyke net and fish trap-pump.

			Passage[a]	
Date	Gates open	Hours run	Net	Pump
4/18/80	$1_1 1_2$	4.0	2,837	2,167
4/22/80	$1_1 1_2$	5.3	7,520	7,417
5/13/80	$1_1 1_2 1_3$	0.3	3,181	2,519
5/16/80	$1_2 18_3$	4.7	5,228	8,435
8/19/80	$1_2 18_1 18_2$	7.2	1,256	4,992
8/20/80	$17_3 18_1 18_2$	11.0	4,072	0

[a] *Based on percentage area fished.*

Fish Condition

Tests were conducted to determine descaling and delayed mortality of fish, caused by their passage through the trap-pump sampler. Fish used to evaluate descaling were examined before release and after passing through the fish trap-pump. Fish used for the test showed no descaling before release. After recovery, percentage descaling was estimated for each fish. Descaling ranged from 1-40%, with a median of 0% and a mean of 1.9% per fish. Only 7% of the fish were 10% or more descaled, and conversely, 85% were less than 5% descaled. The hatchery fall chinook recovered to estimate sampling efficiency (150 fish) were also examined for descaling with similar results (Table 15).

We also examined descaling of wild subyearling and yearling salmonids caught with the fish trap-pump. Among 185 subyearlings examined, the median descaling rate was less than 5%. Wild yearling salmonids had median descaling rates of 5.0-15.0%, slightly higher than for subyearlings (Table 15). We suspect that many yearling fish may have been partially descaled prior to entering the trap.

Table 15. Descaling of juvenile salmonids captured in the fish trap-pump.

Date	Gates open	Species	Number examined	Pre-trap % descaling $\bar{X}$	Pre-trap % descaling Median	Post-trap % descaling $\bar{X}$	Post-trap % descaling Median
		Yearling fish					
4/17	$1_1 1_2$	Chinook	47	NA[a]		24.0	10.0
4/18	$1_1 1_2$	Chinook	26	NA		22.9	15.0
4/22	$1_1 1_2$	Chinook	89	NA		12.2	5.0
5/13	$1_1 1_2 1_3$	Chinook	28	NA		16.2	12.5
5/16	$1_1 18_3$	Chinook	70	NA		5.1	5.0
5/16	$1_1 18_3$	Steelhead	15	NA		10.3	5.0
5/16	$1_1 18_3$	Sockeye	12	NA		4.2	5.0
		Subyearling fish					
8/15	$1_2 18_1 18_2$	Chinook[b]	297	0.0	0.0	1.9	0.0
8/15	$1_2 18_1 18_2$	Chinook[b]	150	0.0	0.0	1.1	0.0
8/15	$1_2 18_1 18_2$	Chinook	122	NA		3.9	<5.0
8/19	$1_2 18_1 18_2$	Chinook	63	NA		7.2	<5.0

[a] *River fish which were not available for examination prior to entering sluiceway.*
[b] *Hatchery fish.*

We tested delayed mortality four times with different sources of fish. Mortality rates for test fish ranged from 21-87%; however, mortality of control fish was high also, up to 61% (Table 16). The difference in mortality between the two groups ranged from 9-82%.

The fish for the last three tests were transported to the dam in iced garbage cans and generally showed signs of anoxia prior to release; this stress may have increased the susceptibility of the test fish to mortality. Prior to running the fourth test, fish were held in a tank and allowed to recover after transport, then only healthy appearing fish were used for the test. Differential mortality was 9% in this test (Table 16).

The high mortality of control fish introduces considerable doubt as to the validity of results from these tests. Stress from high water temperatures 66-70°F (18.9-21.1°C) probably contributed to the mortality of both test and control fish. River temperatures at the usual time of peak fish passage in May generally averaged around 55°F (12.8°C). Accordingly, we feel these tests should be repeated when river temperatures range from 50-60°F (10-15.6°C).

CONCLUSIONS

1. Over 4.4 million juvenile salmonids passed through the sluiceway between April 12 and August 29, 1980.

2. Tests with predominately yearling salmonids suggested that fish passage increased directly proportional to flow through gates $1_1 1_2 1_3$; however, the outage of turbine unit 1 during these tests may have biased the results.

3. Passage of subyearling salmonids through the sluiceway was significantly higher (over four times) at inflows of 3,500 cfs (99 m^3/s) than at 1,600 cfs (45 m^3/s), when northeast gates were opened.

4. Overall bypass efficiency of the sluiceway was estimated indirectly at 64%, and directly at 41-61% for yearling coho. However, our direct estimates appear to have been biased by abnormal behavior of test fish. Our attempt to estimate bypass efficiency of subyearling fall chinook failed when the test fish did not migrate.

5. We found no significant difference in passage of subyearling chinook through gates $1_1 1_2 1_3$ or $17_3 18_1 18_2$.

6. Estimated mean daily passage of subyearling chinook through the sluiceway from October through December ranged from 1,200 in December to 2,500 fish in November. The pattern of diel passage for fish at this time was similar to that during the peak passage period, April through August. Over 400,000 juvenile shad passed through the sluiceway daily during October through December, with passage peaking at 4.8 million shad per day.

7. Sampling efficiency of the fish trap-pump compared favorably with fyke net efficiency when southwest gates were opened, but was very low with northeast gates open. The trap intake will have to be adjusted to effectively sample when northeast gates are open.

Table 16. Estimated mortality of juvenile salmonids sampled with the fish trap-pump.

Test	Date	Source of fish	Test duration (days)	Test fish		Control fish		Differential mortality (%)
				number released	Mortality %	Number	Mortality %	
1	8/15	The Dalles sluiceway	4	117	20.5	---[a]	---	---
2	8/28	Cascade Hatchery	4	145	83.4	150	1.3	82.1
3	9/3	John Day Dam gatewells	2	104	86.5	104	60.6	25.9
4	10/6	John Day Dam gatewells	2	21	28.5	26	19.2	9.3

[a] *A control was not used.*

8. The fish trap-pump sampling apparatus is not a serious source of descaling of juvenile salmonids. Results from test releases of fish indicated that mean descaling was less than 2% per fish.

RECOMMENDATIONS

1. The relationship between inflows and fish passage through the sluiceway should be investigated further with southwest gates open to determine if reduced flow could be used to pass large numbers of juvenile salmonids through the sluiceway.

2. Split gate combinations should be evaluated more thoroughly to determine if they may increase bypass efficiency of the sluiceway over that obtained through adjacent gate openings on either the northeast or southwest ends of the powerhouse.

3. If the northeast skimmer gates are to be used with the fish trap, the trap entrance should be relocated.

4. Delayed stress mortality caused by the fish trap-pump apparatus should be evaluated in the spring when river temperatures are more characteristic of those during the bulk of the juvenile salmonid outmigration.

5. Bypass efficiency of the sluiceway should be estimated utilizing naturally migrating fish.

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APPENDIX

Common and scientific names of major fish sampled in the sluiceway at The Dalles Dam.

Salmonidae:

Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*Oncorhynchus kisutch*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead trout	*Salmo gairdneri*

Others:

American shad	*Alosa sapidissima*
Northern squawfish	*Ptychocheilus oregonensis*
Walleye	*Stizostedion vitreum*